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Dynamic System Simulation for Hybrid Powertrain with AutoLion-ST™

Introduction

Electric energy storage systems often include more than one energy sources, e.g. plug-in hybrid vehicles and renewable energy storage. In such systems, optimum dynamic load sharing between the two energy sources (one of them being Li-ion battery pack) is necessary to maximum system efficiency and safe and durable operation. In addition, system integrator will have to identify the best energy sources (lead-acid battery vs Li-ion battery vs ultra capacitor etc.) and system configuration (series or parallel) that can meet system performance requirement as well as meet size and cost restraints. A software-in-loop approach is very attractive for such systems not only to develop and evaluate best operating strategies but also to conduct system architecture trade-off studies.

Problem Definition

Simulate performance of a hybrid PEM fuel cell and Li-ion battery system at 0°C and 25°C ambient (and initial) temperatures under constant system load.

Technology Used

AutoLion-ST™

Setup

- Co-simulation of battery pack and fuel cell in series hybrid system arrangement, as depicted in figure 1
- 7kW hydrogen PEM fuel cell stack (simulated using EC Power AutoPEM-ST™ software)
- 10kWh NMC/graphite Li-ion battery pack (simulated using EC Power AutoLion-ST™ software)
- Constant system external load of 7.5 kW

Results

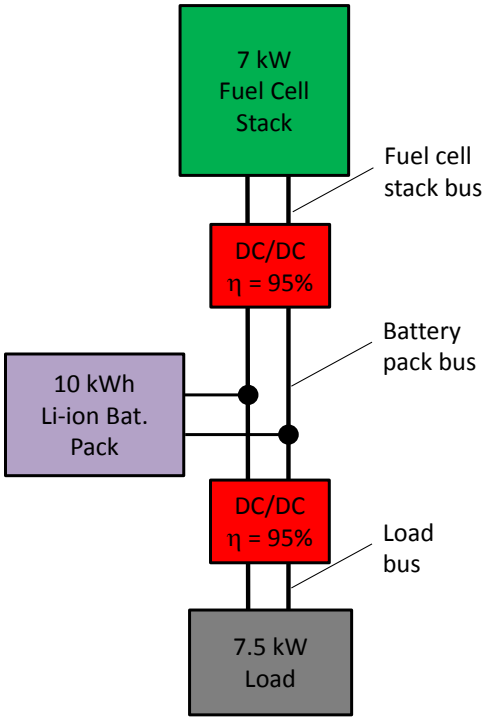

Figure 1: Series PEM fuel cell and Li-ion battery hybrid system.

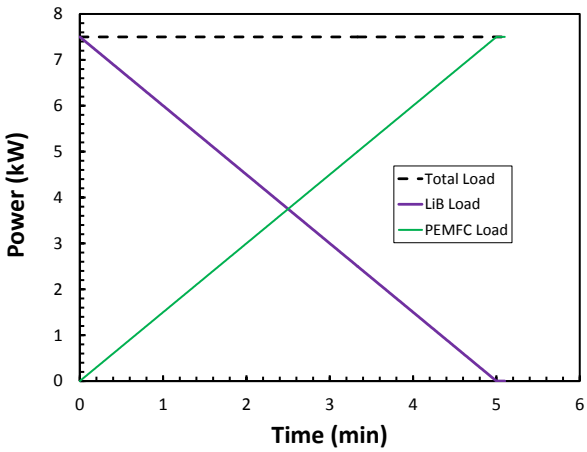

Figure 2: Dynamic load sharing between fuel cell stack and Li-ion battery pack to sustain user demand of 7.5 kW power.

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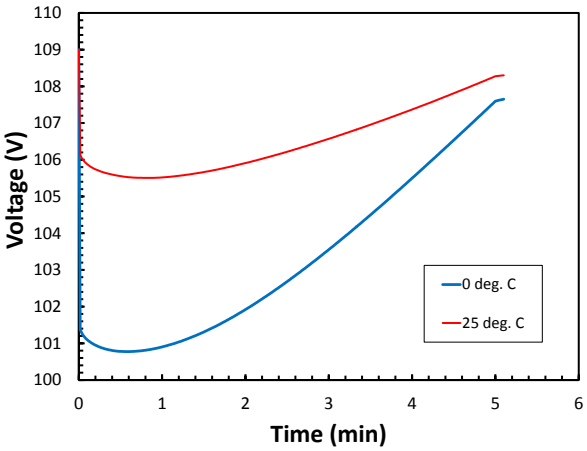

Figure 3: Li-ion battery pack voltage for 0°C and 25°C ambient/initial temperatures.

Benefits

- AutoLion-ST™ is perfectly suited for evaluating dynamic load sharing strategies as well as architecture trade-off studies for any hybrid energy storage system.
- Greater Li-ion battery pack overpotential at 0°C leads to lower voltage and greater current to generate required load
- Li-ion battery pack voltage recovery attributed to both reduced load (over time) and battery self-heating during discharge
- With AutoLion-ST™, custom controls, system designs, and thermal management strategies can be readily developed for a hybrid energy storage system with any combination of two energy sources such as but not limited to lead-acid battery coupled with Li-ion, two Li-ion batteries or fuel cell-battery hybrid. Contact EC Power for lead-acid battery or fuel cell system tools.